SCIENCE ABSTRACTS.

Section A.—PHYSICS.

FEBRUARY 1911.

GENERAL PHYSICS.

184. *New Impact Testing Machine.* **R. D. MacLachlan.** (Engineering, 90. pp. 860–861, Dec. 23, 1910.)—The machine is on the principle of a weight falling on a plate and applying an impact tensile load. With such machines it is desirable that the load should be applied directly, so that as little as possible of the energy of the falling weight is lost in the intermediate connections. In the machine described the plate which receives the blow is made very stiff and is screwed directly on to the specimen. Precautions are also taken to ensure that the blow from the weight on to the specimen is a fair one, and that there is no bending as well as tension stress on the specimen. The weight or tup is of cast iron, accurately turned to fit the central rod, and it weighs 82·04 lbs. It is raised by means of a windlass. A small key on the tup runs in a key-way on the central rod, to ensure that there is no rotational motion of the weight when falling. The energy absorbed in fracturing the specimen is measured in two ways: (1) The velocity of the falling weight is measured; (2) the kinetic energy of the weight after fracture is recorded. The second method is not considered so satisfactory as that of measuring the change in velocity. Preliminary tests are recorded. A bar of mild steel $\frac{9}{16}$-in. diam. of ordinary commercial quality was selected, and all specimens were cut from it. Test-pieces were screwed $\frac{1}{2}$ in. and turned and accurately ground to $\frac{1}{4}$ in. diam. for the middle 2 in. The specimens were subjected to different heat treatments, with the object of determining the effect of such treatment on the power of the material to resist shock. In all cases the elongations due to impact testing are greater than those due to tension testing. Increase of temperature during annealing appears to reduce the total extension under the static load and the impact load. The effect of cooling the specimens in water is very marked, the elongation in both static and impact tests being much reduced. The preliminary tests showed that the measurement of the velocity on the drum of the chronograph was not satisfactory. A stroboscopic method has been adopted which is a great improvement. C. A. M. S.

185. *Thermodynamics of a Material during Change of Shape in the Elastic and Plastic States.* **R. Plank.** (Zeitschr. Vereines Deutsch. Ing. 54. pp. 1854–1859, Oct. 29, 1910.)—When a metallic specimen such as a wire is extended by a tensile pull its volume is increased, and if this increase is very rapid we have a case of adiabatic expansion of a metal. Most previous mathematical investigations have been carried out on the assumption that the material remains elastic. The present article is an investigation taking into account the change in properties after passing the elastic limit and entering the plastic state. The author starts from the fundamental equations that (1) change of internal energy is equal to external work, or $d\mathrm{U} - \mathrm{AP}dl = 0$, where U is the internal energy, A is the mechanical equivalent of heat, and l the length of the rod. Further, that (2) within the elastic scale dl_1 (the external work) $= -\mathrm{AP}dl_1 = \mathrm{AP}l_0(\alpha d\mathrm{T} + \beta/f_0 . d\mathrm{P})$, where P is the load on the specimen, α the coefficient of linear expansion, β the reciprocal of Young's modulus, f_0 the sectional area, and l_0 the original length. The following is then deduced: $c_\mathrm{P}(\mathrm{T} - \mathrm{T}_0) = \rho x - \mathrm{A}\alpha v_0 \mathrm{T}\sigma + \mathrm{A}v_0\int_0^{\epsilon_3} \alpha d\epsilon_3$; here $\mathrm{C_P}$ is the specific heat, $(\mathrm{T} - \mathrm{T}_0)$ the rise in temperature, ρ is a coefficient of latent energy during the change from elastic to plastic state and found by H. Hort to approximate for iron to 0·1 cal. per kg., x is the ratio of the total extension to the extension before the plastic state, α is the stress at any point, and $\mathrm{A}v_0\int_0^{\epsilon_3} \sigma d\epsilon_3$ represents the heat equivalent of the total work put into the bar, $\int_0^{\epsilon_3} \sigma d\epsilon_3$ being the area of the load-extension diagram. It is with this latter factor that the author deals at considerable length. He shows that we can express it as equal to $(n/\kappa)[(\sigma - \sigma_0)^{n+1}/(n+1) + \sigma_0(\sigma - \sigma_0)^n/n]$, where σ is the stress at any point, σ_0 the stress at elastic limit, and $\kappa = (\sigma_3 - \sigma_0)^n/\epsilon_3$; σ_3 is the max. stress, ϵ_3 the corresponding extension, and n is some constant to be determined. This brings the thermodynamic equation to—

$$c_\mathrm{P}(\mathrm{T} - \mathrm{T}_0) = -\mathrm{A}\alpha\mathrm{T}_0 v_0 \sigma - \rho(\sigma - \sigma_0)^n/\epsilon_3\kappa + (n\mathrm{A}v_0/\kappa)[(\sigma - \sigma_0)^{n+1}/(n+1) \\ + \sigma_0(\sigma - \sigma_0)^{n-1}/n].$$

Three cases are considered in detail where n is equal to 2, 3, and 4 respectively. The author gives tables of results and curves of the load-extension and relation between stress and change of temperature corresponding to these values of n, and shows the results to differ to no considerable extent. The values of the constants taken are: $\mathrm{A} = 1/427$, $\mathrm{T}_0 = 293°$ abs. (20° C.), $c_\mathrm{P} = 0{\cdot}11$ and $\rho = 0{\cdot}11$ cal., $\sigma_3 = 4000$ kg./cm.², $\epsilon_3 = 0{\cdot}2$ and $\sigma_0 = 2000$ kg./cm.². The author then discusses the value of Poisson's ratio, denoted by $1/m$, and after deducing the equation $m^2 - 11\epsilon m + 10\epsilon^2 dm/d\epsilon = 0$, arrives at several interesting facts and gives the values of m when ϵ_3 has various practical values. He also gives and discusses the experimental fact that when subject to change of state under stress the value of the specific heat changes. An iron cylinder 80 mm. diam. and 60 mm. high was compressed to 44 mm. high. The mean of 5 tests showed the specific heat to increase in the second case by about 1¼ per cent. C. A. M. S.

186. *An Aerodynamical Problem.* **L. Orlando.** (N. Cimento, 20. pp. 46–51, July, 1910.)—A half-cylinder of wood is suspended in indifferent equilibrium on an axis passing through the axis of the cylinder. The plane surface containing the axis is exposed to an air current impinging upon it

vertically. When the half-cylinder is given a slight rotation in either direction, that rotation is increased and maintained by the air-blast. The author gives a qualitative explanation of this effect, and describes similar phenomena obtained with blocks of different sections. E. E. F.

187. *Inversion of the "Magnus" Effect.* **M. A. Lafay.** (Comptes Rendus, 151. pp. 867–868, Nov. 14, 1910.)—Magnus has shown that a cylinder rotating in a current of air about an axis normal to that current experiences, besides the directly acting force of the air current, a lateral force acting against the side on which the rotary movement is opposed to that of the air current. The author points out that the magnitude of this force is influenced by the nature of the surface of the cylinder. The paper gives results of experiments on a smooth cylinder, 7·2 cm. in diam., and 80 cm. long, in wind currents varying from 11 to 32 m. per sec., and rotating at speeds ranging from 500 to 3000 r.p.m.; the tests being repeated on the same cylinder covered with a rough envelope. It is shown that with a wind velocity of 32 m. per sec., and at a rotation speed of 2500 r.p.m., the "Magnus" effect of + 150 gm. with a rough cylinder was converted to a negative force of − 210 gm. with a smooth cylinder. C. A. B.

188. *Intensity of Periodic Fields of Force.* **A. Stephenson.** (Phil. Mag. 20. pp. 844–848, Nov., 1910.)—This is a mathematical investigation of the nature of the motion of a system about a position of equilibrium in a periodic field of force. It depends on the intensity of the field, and, in general, there is a cumulative effect within each of a series of ranges of intensity, the period of the motion in the odd ranges being twice that of the field, and in the even ranges equal. The problem is of importance in connection with motions which are maintained by a periodic field of force, *e.g.*, the "phonic wheel," in which "the essential feature is the approximate closing of the magnetic circuit by an electromagnet, fed with an intermittent current, by one or more soft-iron armatures carried by the wheel and disposed symmetrically round the circumference." In some cases the oscillations of the motion about the phase in which it should settle down are very persistent and interfere with the application of the instrument. A remedy may be found in a ring containing water, or mercury, revolving concentrically [Rayleigh's *Sound*, 7. § 68]. The investigation is applied to the examination of such methods of securing steadiness and their significance. G. W. de T.

189. *Seismic Activity in the Yun-nan District in* 1909. **J. Deprat.** (Comptes Rendus, 151. pp. 1011–1014, Nov. 28, 1910.)—During 1909 there occurred in the district of Yun-nan lying between Yunnan-Sen and Mong-Tseu a series of disastrous earthquake shocks. The author shows from the form of the isoseismic lines that these disturbances were probably caused by slipping along a great fault which stretches in a N.–S. direction. The rock strata in the district are excessively contorted, and a geological survey of the region has shown it to exhibit all the usual indications of great instability. A. D. R.

190. *Quasi-elastic Forces due to Brownian Motions.* **O. M. Corbino.** (Accad. Lincei, Atti, 19. pp. 817–828, June 16, 1910. N. Cimento, 20. pp. 5–12, July, 1910. Phys. Zeitschr. 11. pp. 756–761, Sept. 1, 1910.)—While admitting that Einstein's treatment of Brownian motions [Abstracts Nos. 1909 (1905), and 748 (1908)] is both elegant and rigorous, the author finds certain advantages in treating Brownian motions as equivalent to a quasi-elastic force

opposing any orientation or distribution of molecules or small particles due to a field of force. He gives two examples of the application of this method—one for the concentration of a solution, and another for the magnetic double refraction discovered by Majorana, Cotton, and Mouton [Abstract No. 585 [1906]. In this connection, and with the aid of Perrin's observations on the Brownian motions of rotation, he calculates the time required for the disappearance of magnetic double refraction on cancelling the magnetic field. For particles 0·2 μ in diam. the time required is 1/40 sec. But actually the time required is less than 1/20000 sec., as proved experimentally by the author. This acceleration is probably due to a mutual action of the particles.
E. E. F.

191. *Seiches in Suwa Lake, Japan.* **A. Tanaka** and **S. Nakamura.** (Mathematico-Physical Soc., Tōkyō, Proc. 5. 20. pp. 894–898, Oct., 1910.)—The lake, 5 km. by 8 km., lies at an altitude of 760 m., and is very shallow, mean depth 4·4 m., max. depth 7·8 m. Seiches were observed by S. Fujiwara and F. Hashimoto with a limnimeter of Honda; the periods were 20·8, 16·2, 9·2 min., also 12·2 min. This agrees with Terada's calculations, and with the experiments conducted on a model of the lake, made in cement on a scale of 11:1000 for depth. The observations of the nodes, with the aid of powdered Al strewn on the model, were less satisfactory. H. B.

192. *Colour of the Sky.* **E. Bauer** and **M. Moulin.** (Comptes Rendus, 151. pp. 864–866, Nov. 14, 1910.)—Assuming Raleigh's theory as to the light of the sky being due to the dispersion of solar light by molecules of air, we are able to calculate Avogadro's constant (the number of molecules per gm.-molecule). The result obtained will, however, be too small if particles such as dust or moisture are present in the atmosphere. The authors have made a series of spectrophotometric observations on Mt. Blanc, working in the neighbourhood of the C, D, and *b* lines of the spectrum. They have obtained some 20 values for N ranging from 18×10^{-22} to 75×10^{-22}, and calculated on the assumption that the albedo of the earth is 0·5. The meteorological conditions were not particularly good, and it is proposed to repeat the work.
A. D. R.

193. *Extra Telluric Solar Radiation.* **F. W. Very.** (Science, 32. pp. 876–877, Dec. 16, 1910. Abstract of paper read before the Astronom. and Astrophys. Soc. of America, Aug., 1910.)—The chief objection to static methods in actinometry arises from the difficulty of satisfactorily determining the instrumental corrections. The author proposes to eliminate the most troublesome of these by the following method. Exposing a strip of the thinnest Pt, coated with platinum black, to the solar rays at the focus of a condensing mirror, and gradually increasing the aperture of the mirror by means of an iris diaphragm, a point is reached where a further increase of the aperture will almost instantly melt the Pt. The observer will by previous experiment so heat the Pt-foil until the loss by conduction into the supports has assumed a steady value, requiring about two minutes. The method avoids the necessity of applying an uncertain correction for loss of heat by convection, because, owing to the viscosity of air at high temperatures and the slow motion of the air, the loss by convection in the short time required to melt the Pt is negligible. An observation by J. M. Schaeberle on these lines, using Stefan's formula with Kurlbaum's constant, gives 6568° abs. as the solar temperature, and the solar constant 8·05 cals. C. P. B.

194. *Spectrum of Chromosphere.* **W. S. Adams** and **H. G. Gale.** (Science, 32. p. 881, Dec. 16, 1910. Paper read before the Astronom. and Astrophys. Soc. of America, Aug., 1910.)—The work of photographing the spectrum of the chromosphere in ordinary sunlight has been continued, the number of lines obtained comparing very favourably with those photographed during a total eclipse. A marked feature is the tendency to reversal as the sun's limb is approached. Laboratory experiments on the arc under pressure show that arc titanium lines near λ4800 show reversal at 6 atmos., while the enhanced lines remain bright. C. P. B.

195. *Motion of Particles in Tail of Halley's Comet.* **E. E. Barnard.** (Science, 32. p. 877, Dec. 16, 1910. Paper read before the Astronom. and Astrophys. Soc. of America, Aug., 1910.)—The photographs obtained on June 6, 1910, show a discarded tail drifting away from the comet. Measurements of this with respect to the head were made on three photographs taken at William's Bay, Honolulu, and Beirut. Comparisons between the plates of the first two stations give a velocity of the tail particles of 28·0 miles per sec., while those of the last two give 37·4 miles per sec. This indicates a progressive acceleration of the tail matter leaving the comet. C. P. B.

196. *Perturbation of Neptune.* **W. H. Pickering.** (Science, 32. pp. 884–885, Dec. 16, 1910. Abstract of paper read before the Astronom. and Astrophys. Soc. of America, Aug., 1910.)—Examination of comet orbits led the author to suspect the existence of a large dark unknown body, located not far from the sun, and in the general direction of the north pole of the ecliptic. Such a body would produce a peculiar perturbation of the outer planets, forcing them to describe circles of the sphere slightly to the south of their assumed orbits. To test if this were the case the Paris and Greenwich observations have been examined. The orbit of Leverrier is not in agreement with that of Newcomb, and since 1897 the planet has receded further south still. A deviation of 2·2″ from the great circle appears to give the most accordant results. C. P. B.

197. *Photographs of Mars.* **P. Lowell.** (Roy. Astronom. Soc., M.N. 70. 9. p. 652, 1910.)—It has been stated by Antoniadi that the photographs of Mars taken at Flagstaff, Arizona, during the 1909 opposition do not show the polar cap to be brighter than the continental regions. With the present paper is included a plate showing a series of photographs of the planet, demonstrating that the opposite is in reality the case. Moreover, the irradiation from this brilliant cap masks the thin dark border which actually exists around the edge of the polar cap. This is clearly shown in spite of the fact that the photographs were taken in almost monochromatic light (λ5400–5800), which toned down the white caps relatively to the yellowish-tinted continental areas. C. P. B.

198. *Water-vapour on Mars.* **F. W. Very.** (Nature, 84. p. 495, Oct. 20, 1910.)—In questioning a statement attributed to W. W. Campbell that the nights of Sept., 1909, on which spectrograms of Mars were obtained on Mount Whitney, were perfect for the purpose, Very suggests that although the sky may have been clear, and the surface humidity low, this does not of itself prove that the aqueous vapour in the upper air was small in amount. The bolometric investigations of Fowle have shown that the absorption by water-vapour in north temperate latitudes is decidedly at maximum in Sept., and minimum in Feb. Measurements of the absolute density of the *a* water-vapour band on spectrograms of Mars taken at Flagstaff during Jan. and Feb., 1908, showed conclusively that it was stronger in the spectrum of Mars than in that of the moon. C. P. B.

199. *Bright Projection on Saturn.* **M. Maggini.** (Astronom. Nachr. No. 4445. Nature, 84. p. 507, Oct. 20, 1910. Abstract.)—Observing with a 35-cm. Calver telescope at the Ximeniano Observatory, Florence, on Sept. 29, at 23h. 36m. (Central European Mean Time), a bright projection was seen in profile against the shadow cast by the planet on the ring, near to a large white spot at the edge of the south equatorial band. The appearance was visible until Sept. 30 at 0h. 20m. C. P. B.

200. *Brightness of Halley's Comet.* **J. Stebbins.** (Astrophys. Journ. 32. pp. 179–182, Sept., 1910.)—Measurements with a selenium photometer [Abstract No. 1085 (1908)] on a 12-in. equatorial gave the variations of brightness of the comet during May, 1910. On May 3 the stellar magnitude was about 2·0; it increased to first magnitude by May 20, afterwards decreasing to 3·6 on June 1. C. P. B.

201. *Photographic Observations of Meteor.* **Sykora.** (Astronom. Nachr. No. 4447. Nature, 84. p. 544, Oct. 27, 1910. Abstract.)—On Aug. 11, 1909, a bright meteor was photographed simultaneously at the three stations Taschkent, Iskander, and Tschimgan. Various features of the trail are well shown on all plates, so the heights can easily be determined. The altitude varied from 112 km. to 81 km. C. P. B.

202. *Stellar Parallax Determination.* **C. Nordmann.** (Comptes Rendus, 151. pp. 794–796, Nov. 7, 1910.)—By combining his method of heterochromic photometry with the deduction of mass of spectroscopic double stars from their determined radial velocities, the author gives an equation which is used to calculate parallaxes of the stars investigated. In the case of Algol the parallax so determined is given as 0·055", which is close to Bigourdan's latest value 0·051". For the spectroscopic double δ Librae, the value is 0·009". C. P. B.

203. *Brightness of Stars with Selenium Photometer.* **J. Stebbins.** (Astrophys. Journ. 32. pp. 185–214, Oct., 1910.)—Previous experiments with selenium photometry had enabled the author to determine the variations of the moon's light throughout a lunation [see Abstract No. 894 (1908)], and it was further pointed out that selenium cells exhibited widely different ranges of colour sensibility. From numerous experiments it was found that three conditions primarily tended to uniformity in the working, viz., (*a*) uniform temperature of the selenium, 0° C. or lower; (*b*) continuous passage of the current; (*c*) short exposures to the light, with long intervals for recovery. Special attention was given to the determination of the variations in the light of the short-period variable Algol. Under good conditions a 10-sec. exposure to the star at maximum gave a scale deflection of 8·0 mm.; α and δ Persei were used as comparison stars. The values obtained during the period of variations are plotted, showing distinct evidence of a secondary minimum, suggesting that the companion is not wholly dark. From the analysis of the variations several provisional sets of elements are derived, and a list of the principal constants of the system are given for comparison with other records. C. P. B.

204. *Collimation Adjustments in Photographing Stellar Spectra.* **J. S. Plaskett.** (Astrophys. Journ. 32. pp. 243–248, Oct., 1910.)—When a visual refractor is used for photographing stellar spectra it is necessary to use a correcting lens to bring a larger range of spectrum to focus on the slit plate. From various anomalies in the spectra obtained at the Dominion Observatory, Ottawa, it was found that the correcting lens was slightly out of collimation with the main objective, and careful examination showed that the system was very sensitive to minute variations from exact collimation. To allow of this being regulated, a screw adjustment has been provided and the position will be varied to compensate for different flexures of the tube at varying zenith distances. C. P. B.

205. *Probable Errors of Radial Velocity Determinations.* **J. S. Plaskett.** (Astrophys. Journ. 32. pp. 230–242, Oct., 1910.)—A series of observations on the influence of slit-width on the probable error of radial velocity determinations has been already published [Abstract No. 34 (1909)]. The present paper deals with the possible effects of changes in the dispersion of the instrument employed and in the type of spectrum presented by the star under examination. To eliminate the effect of broad lines, the star selected for the comparison was Arcturus, giving sharp lines of the solar type, and to avoid errors due to blends of multiple lines all the plates were measured with the spectro-comparator. With a three-prism spectrograph the average probable error appears to be about 0·5 km. per sec. for a star with well-defined lines, and may be from 2 to 11 km. per sec. for a star with wide, diffuse lines. Generally speaking, the major part of the errors in solar-type stars are probably due to systematic changes of flexure, temperature, guiding, and imperfect optical adjustment. C. P. B.

206. *Spectra of Close Double-stars.* **A. J. Cannon.** (Science, 32. p. 885, Dec. 16, 1910. Paper read before the Astronom. and Astrophys. Soc. of America, Aug., 1910.)—Of the group of stars exhibiting peculiar spectra 46 have been classified as composite. These may be subdivided into two groups, according as the brighter component is of an earlier or later class than the fainter. The most interesting case is 6 Cygni, which is the brighter component of the well-known double star β Cygni. The visual companion whose spectrum is of class A is quite separate on the photograph, and so does not interfere with the problem. The K-line is exceedingly faint in the spectrum of this star. Measures of radial velocity show no evidence of variation. C. P. B.

207. *Systematic Motions of Boss's Catalogue Stars.* **A. S. Eddington.** (Roy. Astronom. Soc., M.N. 71. pp. 4–42, Nov., 1910.)—The catalogue of proper motions published by Boss furnishes a series of accurately determined values for stars well distributed over the whole sky, all having a high degree of accuracy, and including both bright and faint stars. In the discussion the word *stream* is used to denote the tendency of a group of stars to move in a favoured direction; the word *drift* to denote a system having a distribution of individual velocities according to Maxwell's law. On account of certain peculiarities found in connection with the stars of the Orion spectrum type, these were omitted from the discussion. For the analysis the sky has been divided into 34 zones of approximately equal extent, and the proper motions regarded as projected on the tangent planes at the centres of these areas. To facilitate the work the regions diametrically opposite each other were treated together; this procedure rendering it advisable to arrange a subsequent analysis of the separate areas to detect any variations of the two drifts with respect to the sphere. The directions of motion of all the stars in each region were computed, and then the number moving within each 10° of position angle were counted. The results were plotted diagrammatically, showing very clearly the evidence for the existence of the two streams. The convergence of the directions has been determined by both Bessel's and Airy's methods, and the former is reproduced graphically, showing a very close approximation to a definite apex. Drift I. is quite clearly distinct from the solar motion. A table is given showing comparisons of the results obtained by all workers on this problem. The work of Dyson and Hough and Halm had indicated that Eddington's speed of Drift II. from the Groombridge proper motions was too low, and the present result confirms this in finding a higher velocity. The stars of Drift I. are more numerous than those of Drift II. in the ratio 3 : 2. There is no evidence of any intimate relation between the stars of Drift II. and the Galaxy. C. P. B.

208. *Photographs of Nebulæ.* **G. W. Ritchey.** (Roy. Astronom. Soc., M.N. 70. 9. pp. 647–649, 1910.)—Photographs of the nebulæ M 13 Herculis, M 33, Hv 24, NGC 6960, NGC 6992, M 64, and the Ring Nebula in Lyra have been taken with the 60-in. reflector at the Mount Wilson Solar Observatory, California. In M 13, 26,700 stars have been counted in the zone outside the area of superposition in which it is impossible to discriminate between the separate images. Other plates of M 33 Trianguli show the typical spiral structure very perfectly. In the nebula M 64 Comæ Berenices there is presented the interesting peculiarity that the nebulous stars are present only in the central parts of the nebula, being entirely absent from the outer convolutions. This is the exact opposite to the conditions in M 81 Ursæ Majoris and the Great Andromeda nebula, where the central regions contain no nebulous stars whatever, as far as is known, while the outlying spirals show thousands of stars. C. P. B.

209. *General Discussion of Stellar Radial Velocities.* **W. W. Campbell.** (Science, 32. pp. 875–876, Dec. 16, 1910. Paper read before the Astronom. and Astrophys. Soc. of America, Aug., 1910.)—From a discussion of the radial velocities of more than 1000 stars, observed for the most part at the Lick Observatory and its southern station at Santiago, Chile, the following coordinates for the position of the apex of the sun's way have been determined: Right ascension, 272·0° ± 2·5°; declination + 27·5° ± 3·0°; velocity of sun in space = 17·77 km. per sec. The stars were tabulated with regard to spectral type, and the interesting fact was found that the velocities increase as the type advances; thus the stars of type B have an average velocity of 9·0 km.; those of A type 10 km.; F type 14 km.; G and K types 15 km.; and M type 16·5. An important relation is found between the distributions of Kapteyn's drift stars in that stars in the neighbourhood of Kapteyn's vertex and antevertex appear to have velocities about 33 per cent. greater than stars situated about 90° from these regions. C. P. B.

210. *Spectra of Sirius, Procyon, and Arcturus with High Dispersion.* **W. S. Adams.** (Science, 32. pp. 881–882, Dec. 16, 1910. Paper read before the Astronom. and Astrophys. Soc. of America, Aug., 1910.)—A series of spectra have been obtained with a high-power Littrow spectrograph attached to the 60-in. reflector of the Mount Wilson Solar Observatory. The displacements with respect to comparison air lines have been measured for the

enhanced lines and the arc lines. The shifts are found to be in the same direction as that found at the limb of the sun, and may probably be ascribed to pressure. In Sirius the gaseous pressure is probably about 12 terrestrial atmos., and in Procyon 7 atmos. C. P. B.

211. *Order of Stellar Evolution.* **H. N. Russell.** (Science, 32. pp. 883–884, Dec. 16, 1910. Abstract of paper read before the Astronom. and Astrophys. Soc. of America, Aug., 1910.)—Assuming that a star grows denser as it advances in evolution, that it is in equilibrium under its own gravitation, and that its constituents behave like the gases with which we are familiar, it has been shown by Ritter and others that such a star will grow hotter as it contracts (Lane's law) until its density reaches a critical value. Stars having a temperature less than this maximum may be of two kinds—one increasing, the other decreasing in temperature. Taking into consideration the various spectral types, it is an observed fact that among spectroscopic binaries those of shortest period belong to type B. Examining the proper motions of the redder stars from type G onwards, they divide somewhat sharply into two groups—one consisting of remote stars, with small proper motion, and great luminosity, the other of near stars, showing large proper motions and small luminosity. These facts appear to be consistent with the view that stars of type B have the highest surface temperature and those of type M the lowest. C. P. B.

REFERENCES.

212. *Theory of the Bourdon-tube Compound Pressure Gauge.* **H. Lorenz.** (Zeitschr. Vereines Deutsch. Ing. 54. pp. 1865–1867, Oct. 29, 1910.)—The author discusses the general case of the stresses induced and the change of shape, when a tube of any section, bent into the arc of a circle is subjected to internal pressure. He deduces standard differential equations by which any particular cross-section can be evaluated. In most practical instruments an elliptical section is employed, and he therefore works this case out in full, illustrating the method of using the formulæ by a practical example. C. A. M. S.

213. *Flow of Fluids under Inconstant-pressure Conditions.* **R. Löwy.** (Akad. Wiss. Wien, Sitz. Ber. 119. 2a. pp. 799–814, May, 1910.)—A mathematical treatment of the streaming which occurs in the case of fluid flowing on both sides of a blade, as in the case of turbines or centrifugal pumps.

214. *Relativity Theory.* **T. Kaluza.** (Phys. Zeitschr. 11. pp. 977–978, Nov. 1, 1910. Paper read before the 82. Naturforscherversamml. Königsberg, Sept., 1910.)—Discusses the rotation of a rigid body and the higher geometry that applies to it so as to represent the phenomena on the relativity theory. E. H. B.

215. *Rotation of the Sun.* **F. Schlesinger.** (Science, 32. pp. 880–881, Dec. 16, 1910. Paper read before the Astronom. and Astrophys. Soc. of America, Aug., 1910.)—From a series of photographs taken with the third order of a Michelson grating of 500 lines to the mm. thirty-seven lines between λ4059 and λ4147 were selected and the displacements due to rotation determined on eighteen plates. The results showed no systematic tendency for the various lines due to the same substance. C. P. B.

216. *Orbit and Spectrum of o Persei.* **F. C. Jordan.** (Science, 32. pp. 880–881, Dec. 16, 1910. Paper read before the Astronom. and Astrophys. Soc. of America, Aug., 1910.)—The spectrum of each component appears to be identical—type B_2—the only difference being that of brightness. The ratio of the masses appears to be 1·43 : 1. The velocity of the centre of mass of the system is + 18·46 km. C. P. B.

LIGHT.

217. *Apparatus for the Production of Circularly Polarised Light.* **A. E. Oxley.** (Chem. News, 102. pp. 189–190, Oct. 14, 1910.)—Two arrangements are described, which have the object of producing a beam of circularly polarised light without involving the inconvenience of lateral displacement met with in using Fresnel's rhomb. A quarter-wave plate does not produce lateral displacement, but its use is limited to monochromatic light. The first device consists of two glass rhombs placed end to end, and sloping opposite ways. A beam incident at 45° on one end suffers four internal reflections, and emerges at the other end in line with its original direction. This apparatus is inconveniently large in proportion to aperture, and a second, more compact, form is therefore described, involving three total reflections. Either form is mounted in a metal cylinder with central apertures and is said to be more efficient than Fresnel's rhomb. It is suggested that the second form would prove useful in analysis of elliptic vibrations. The construction will be understood on referring to the diagrams in the original article. A. E.

218. *A New Form of White-Light Half-Shade.* **A. E. Oxley.** (Chem. News, 102. p. 190, Oct. 14, 1910.)—The arrangement of rhombs in the first form of polariser described in the preceding Abstract may be used to form a white light half-plate. Half the field of view is occupied by a rhomb, and the other half by one of two blocks of glass whose use is to compensate for loss of light by reflection or absorption. This form of half-shade (using white light) has been compared with the Laurent half-shade (using monochromatic light) and was found to be quite as efficient. In view of the cost of large blocks of calcite, this new analyser may prove useful for ordinary laboratory determination of rotation of the plane of polarisation. The length of the half-shade for an aperture of 1·6 cm. square is 8 cm. A. E.

219. *New Sixteen-inch Photographic Doublet.* **J. H. Metcalf.** (Science, 32. p. 878, Dec. 16, 1910. Paper read before the Astronom. and Astrophys. Soc. of America, Aug., 1910.)—A new doublet of 16¼-in. aperture has been constructed and is being tested at the Harvard Observatory. It is of the Petzval-Voigtländer type with relative aperture of *f*/5·5. The chief points of interest are (*a*) the employment of dense flint glass, (*b*) the correction for astigmatism (*c*) the elimination of coma. The few remaining errors have been almost eliminated by employing plates curved to the same degree as the field of the lens. Practically the only uncorrected error is the secondary chromatic aberration inherent in all lenses composed of crown and flint glasses.

C. P. B.

220. *Isolation of Long Heat Waves by Quartz Lenses.* **H. Rubens** and **R. W. Wood.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 52. pp. 1122–1137, 1910.)—The method depends on the selective reflection of quartz. Earlier experiments with thin quartz prisms entailed the use of a spectrometer, with resulting loss of light. This drawback is avoided by using lenses instead of prisms. The method has, however, the disadvantage that the radiation is not very homogeneous, the region isolated extending from 80 to 200 μ. An

incandescent gas-mantle forms the source. The rays pass through a hole in a screen, next through a quartz lens, then a hole 15 mm. diam. in a second screen, a second quartz lens, and finally fall on a micro-radiometer. The interval between each lens and screen is 26 cm., and the focal length of the lenses for visible rays is 27·8 cm., their diam. 7·5 cm. The centre of each lens is covered by a small black paper disc 25 mm. diam. The discs and second screen are required to stop out short heat waves, a good many of which find their way through the lenses, though the strong selective absorption of quartz for the region 60–80 μ assists to cut them off. Wave-length and distribution of energy can be investigated by inserting an interferometer behind the first lens. The transparency to the long heat waves of sheets of various substances was tested, the thickness varying from a fraction of a mm. to several mm. A diamond plate 1·2 mm. thick is quite transparent to the radiations. Paraffin and quartz are transparent even in thick layers. Black paper transmits a considerable proportion, and even black cardboard is not quite opaque. A thin layer of stearine, though opaque to sunlight, absorbs very little of the long-wave radiations. Water is opaque, even in a film of only 0·16 mm., and benzol very transparent. Tests of vapours show that, per number of molecules traversed, they are more transparent than the liquids. The reflecting power of several materials for the long heat waves was investigated also, with a suitably modified form of the above apparatus. In the case of rock-salt, fluor-spar, and glasses, the observed reflecting power for the region about 108 μ nearly approaches R_∞, the reflecting power for waves of infinite length, calculated from the dielectric constant. For sylvin also, the agreement between the two quantities is much closer than at 82 μ (Reststrahlen of KBr). In the case of chalk, marble, and the liquids examined, there is no such agreement. The indices of water and alcohol in the region of great wave-length are of the same order as in the visible spectrum. The index calculated for water is 1·9, but owing to the inhomogeneity of the radiation, the calculation has small weight. Probably the high value (11·6 per cent.) of the reflecting power found for water is due, not to a large index, but to the proximity of absorption bands.

A. E.

221. *Improvement of Binocular Microscope by increasing the Illumination of the Observed Objects.* **C. Cépède.** (Comptes Rendus, 151. pp. 948–959, Nov. 21, 1910.)—The inconvenience caused by the presence of a zone of shade on the object is counteracted by employing a concave mirror, attached to the instrument by a jointed arm, to reflect light upon the shaded region. For attaching the arm, screws and holes already present in the ordinary mountings are utilised. Three modes of attachment are described: the first makes use of the holes in the stage for fastening slides; the other two, of the screws fixing the upper part of the instrument to the stage. A. E.

222. *The Photographic Plate.* **W. D. Bancroft.** (Journ. Phys. Chem. 14. pp. 620–650, Oct., 1910.)—The "silver bromide grain" is a complex of silver bromide, gelatine, and water. The process of ripening consists in changing the composition of the silver bromide grain towards an unknown optimum concentration. There is no necessary connection between sensitiveness and coarseness of grain. Chemical and optical sensitisers are depolarisers. Gelatine acts as an emulsifying agent and as a sensitiser, whereas collodion apparently acts only as an emulsifying agent. The peptonisation of silver bromide is merely a particular case of the general problem of the peptonisation of any precipitate. The peculiarities of mixtures of AgCl, AgBr, and AgI can all be explained on the assumption that each of these salts can form a continuous series of solid solutions with either of the two. This is known to be the case for AgCl and AgBr. It seems theoretically possible (by incorporating a suitable depolariser or sensitiser with the silver bromide grain and using a suitable developer) to make an almost infinitely fast plate having a very fine grain. [See Abstracts Nos. 891, 986 (1910).] A. D.

223. *Photography by Invisible Rays.* **R. W. Wood.** (Photographic Journ. 50. pp. 329–336; Discussion, pp. 336–338, Oct., 1910. 18th Traill-Taylor Memorial Lecture.)—Photographs made by infra-red rays 7100 to 7600 (through a cobalt glass and dichromate of potash) and ultra-violet rays 3000 to 3200 (through a metallic silver film on quartz lenses) show the following characteristics—(*a*) infra-red rays: White paper lighter than the sky; shadows very black; leaves of trees very white (snow effect); sky black at zenith, grading into lightness towards the horizon. (*b*) Ultra-violet rays: White paper darker than the sky; shadows extremely feeble or absent; window-glass opaque and black; white flowers come out black; reflections in an ordinary mirror absent and black; silver objects seem very poor reflectors, brass and speculum metal much better; chinese white appears black and printer's black ink light in tone. By ultra-violet light a large black patch is found near the lunar crater Aristarchus, showing a large deposit of some specific material [Abstract No. 520 (1910)]. Pictures presenting these characteristics correspond to realities otherwise beyond the grasp of our senses as they are. A. D.

224. *Electron Theory of Optical Properties of Metals.* **H. A. Wilson.** (Phil. Mag. 20. pp. 835–844, Nov., 1910.)—Jeans has established the equation $d/dt\,.(\mathrm{N}mu_0) = \mathrm{NX}e - \mathrm{N}\gamma u_0$ where m is the mass, and e the charge of an electron, N the number of free electrons in the metal, X is the electric force parallel to the axis of x, u_0 the average velocity of an electron parallel to X, and γ is a quantity depending only on the sum of the squares of the velocities, and on constants, subject to the condition that the interval of time dt is large compared with the time of collision between two electrons [see Abstract No. 1268 (1909)]. The author concludes that this equation will, therefore, be strictly correct only for vibrations of much smaller frequency than those in infra-red radiation, and establishes the same equation, free from this restriction, by making $\gamma = \int \beta u d\mathrm{N} / \int u d\mathrm{N}$, where β is a function of the time, of V, the velocity of an electron, and also of m and e. Since u varies with the time, γ will no longer be a constant. He then works out the theory on the lines followed by Jeans, regarding the atoms as hard spheres at rest, and the electrons as hard spheres whose mutual actions may be neglected. The calculation of the rate of increase in the momentum of the electrons due to X then leads to the conclusion that the results will agree with those of Jeans only if all the electrons be regarded as having the same velocity V. The expression then obtained for the conductivity at any frequency is not integrable in finite terms, but by graphical solution the author finds that in most cases the value of N so obtained is about double that given by Jeans's formula. It is found that the extension of the calculation to shorter wavelengths gives no indication of a diminution of E_λ, the energy per unit volume of radiation of frequency between λ and $\lambda + d\lambda$. Both the absorption and emission are diminished, but in the same ratio. On the author's assumptions, the electrons gain or lose energy only from the radiation, so that their velocities will ultimately become uniform, and the value of E_λ will be $8\pi RT\lambda^{-4}$ exactly, as obtained by Jeans. A velocity distribution in accordance with Maxwell's law is therefore inconsistent with the other assumptions. As Maxwell's law no doubt does hold good, and the above value is probably exact, the variation introduced into the author's calculations by assuming Maxwell's law is probably due to the neglect of the motion of the atoms and the mutual influence of the electrons. The author observes that "it now seems very probable that the electron theory in its present form cannot account for the observed values of E_λ." The observed values fall below those calculated for wave-lengths which are very large compared with those of Röntgen rays, which latter are still long enough to be strongly absorbed by dense matter. Short ultra-violet light is even strongly absorbed by air. G. W. de T.

225. *New Method of determining the Optical Constants of Metals, and the Optical Constant of Silicon.* **L. R. Ingersoll** and **J. T. Littleton, Jr.** (Phys. Rev. 31. pp. 489–499, Nov., 1910.)—The method, an application of the half-shade principle, is an extension to the visible spectrum of an arrangement devised by Ingersoll for an infra-red investigation not yet published. If plane-polarised light falls on a metal surface, in principal azimuth ψ, and at principal incidence ϕ, a circularly polarised beam will result on reflection. The optical constants n and k are connected with ψ and ϕ by known relations; hence the problem of determining n and k becomes that of finding the azimuth and incidence for which a plane-polarised beam becomes circular on reflection. It is in the determination of this circular vibration that the present method differs from others. The usual plan is to find the phase-change necessary to produce a given type of polarisation. But here, two components of the elliptical vibration are taken at right angles, and the two halves of the field of view are illuminated by these two sections. When the two halves show equal illumination, no matter how the observing apparatus is rotated about the axis of the beam, then the beam is circularly polarised. The spectrometer, collimator, and telescope are each fitted with a nicol. That on the collimator is just before the objective, as usual; that on the telescope is of the normal incidence type, and replaces the eyepiece. The collimator slit is replaced by a small circular hole. The new system, the "bi-field analyser," is just before the telescope, and consists of a small Wollaston double-image quartz prism, with a bi-prism behind it, giving the same separation. Of the four resulting images, the two outer fall outside the field, while the two middle ones exactly overlap at the telescope focus, where there is a 5-mm. hole in a diaphragm. An eye placed at this point sees the field of view divided into two halves, each half illuminated by one of two beams polarised at right angles. The two halves may be matched by rotating the analysing nicol, interposed at the eyepiece end. While the instrument may not exceed, or even equal in accuracy, the best form of Babinet compensator for the majority of metals, it may prove superior for those metals which give small principal azimuths. The bi-field analyser may be used in place of a Babinet compensator for analysis of any elliptic vibration.

The silicon examined was of 99·75 per cent. purity. The mean of the measures gives for the refractive index $n = 4{\cdot}07$, and for the absorption index $k = 0{\cdot}095$, computed from the angles 76° 36′ for principal incidenec, and 2° 42′ for principal azimuth. The reflecting power is 37·1 per cent. The mean of the Babinet determinations is $n = 4{\cdot}14$, $k = 0{\cdot}15$. v. Wartenberg's results for a specimen of 95 per cent. purity are $n = 3{\cdot}87$, $k = 0{\cdot}116$. A. E.

226. *Liquid Crystals in Convergent Light.* **C. Mauguin.** (Comptes Rendus, 151. pp. 886–888, Nov. 14, 1910.)—Films of azoxyphenetol fused between glass plates, cooled to the temperature at which liquid crystals are formed, and examined in convergent light display all the optical properties of solid crystals. The orientation is usually such that the optic axis is parallel to the plate, but an inclination of the axis is not uncommon. An optic axis perpendicular to the plate occurs only occasionally, but has been observed with dark brushes and ring-system complete, and with no sign of rotatory polarisation; it has been used to determine the sign (positive) of the double refraction. The number of bands increases with the thickness of the film, and it is actually possible by raising the cover-slip to cause a progressive increase in this number, the liquid which flows in to the centre taking up the same orientation as the liquid-crystalline material already present there; on lowering the cover-slip the bands spread out again. With sodium light an increase of thickness of $48\,\mu$ was found to cause 80 bands to traverse the middle of the field in the case of a film with optic axis parallel to the surface, giving for the double refraction a high value 0·87, agreeing closely with the figure 0·88 deduced by Lehmann by other methods. T. M. L.

227. *Magnetic Birefraction of Nitrobenzene in Absolute Measure.* **A. Cotton** and **H. Mouton.** (Comptes Rendus, 151. pp. 862–864, Nov. 14, 1910.)—The value found for the constant C in $\delta/\lambda = ClH^2$, where δ/λ is the retardation expressed in wave-lengths, l is the thickness of the liquid, and H the field intensity, was less than that given by Skinner [see Abstracts Nos. 54, 898 (1910)], and Cotton proceeded to the Brace Laboratory and compared the two methods. A correction was applied to Skinner's numbers for the field intensity which brought the two determinations into accord. The constant was then re-determined by the authors; for nitrobenzene, with the yellow line of mercury, at 16·8° C, the constant $C = 2{\cdot}58 \times 10^{-12}$.

G. E. A.

228. *Fresnel's Diffraction Phenomena with Grating.* **H. Weisel.** (Ann. d. Physik, 33. 5. pp. 995–1031, Nov. 10, 1910. Extract of Dissertation, Giessen.)—The chief results of this research may be summarised as follows: If coherent parallel rays of monochromatic light fall normally upon a grating one may observe, before and behind the plane of the grating, at equal distances from it, like images. The succession of the different interference images is the same for all wave-lengths, but their distances from the diffraction screen are inversely as the wave-length. The width of the images depends upon the distance, and reaches a maximum for a distance which is an exact multiple of d^2/λ, where d is the grating constant. E. H. B.

229. *Photographic Photometry.* **E. S. King.** (Science, 32. p. 884, Dec. 16, 1910. Paper read before the Astronom. and Astrophys. Soc. of America, Aug., 1910.)—In connection with an investigation for critical stellar photometry by photography, the standard laws were tested, it being found that the law of inverse squares, and that of the cosine for inclined surfaces up to 60° were sufficiently valid. A peculiar effect resulting from the work is that a photographic plate is more sensitive when cold than when warm, while the effect of humidity is to materially decrease the sensitiveness. The light of the sky has been measured from noon until 10 p.m., the difference being about 17 magnitudes. In the method of stellar photometry by out-of-focus images many precautions are now taken to ensure the absence of systematic error, five measures of each star being made on five different nights. The distance at which the plate is set from the focal plane precludes the possibility of error arising from slight changes of focus. The great advantage of these methods is that they give absolute values. **C. P. B.**

230. *Monochromatic Illumination for Spectro-photometers.* **A. Callier.** (Ann. d. Physik, 33. 5. pp. 1059–1064, Nov. 10, 1910.)—Strong monochromatic sources of light are indispensable for many physical experiments, in particular, as Martens and Grünbaum have shown [Abstract No. 507 (1904)], for spectro-photometric measurements. Martens and Grünbaum employed (i) sparks between two metal electrodes, (ii) sparks between solutions and metals, (iii) luminous flames, (iv) Geissler tubes, (v) Arons' mercury lamp. The author has used with advantage (i) a quartz mercury lamp with alloys of Zn, Cd, and Tl; (ii) arc lights between carbon electrodes containing metals. The gases from the arc were removed by means of a centrifugal ventilator. The substances dealt with were Al, Ag, Pb, Cu, Cd, Zn, Sn as wires, LiOH, $BaCO_3$, $CaCO_3$, $SrCO_3$ as powder, and KCl, RbCl, CsCl as powder mixed with sand. The positive carbon was bored through the centre, and the material packed into the hole. A table is given of the wave-lengths of the principal lines (ranging from Ca 3934 to Rb 7951 Å.U.) obtained with the different substances used. The methods of illumination for the König-Martens spectro-photometer are described, and a method of purifying monochromatic light by the use of the Wratten and Wainwright light filters is also dealt with. **A. W.**

231. *Number of Centres of Light Emission.* **J. Stark.** (Akad. Wiss. Wien, Sitz. Ber. 119. 2a. pp. 779–797, May, 1910.)—The spectra of a mercury arc lamp and of mercury vacuum tubes worked with two different current strengths were produced by means of a special grating, as many as fourteen different orders being formed. By photographing these spectra, the relative intensities of the same wave-length for the different orders were obtained for each of the three sources. The result is different in each case, and from this the author seeks to deduce data regarding the light-centres. **P. P. Koch.** (Phys. Zeitschr. 12. pp. 12–14, Jan. 1, 1911.) **G. E. A.**

232. *Groove-form and Energy Distribution of Diffraction Gratings.* **A. Trowbridge and R. W. Wood.** (Phil. Mag. 20. pp. 886–898, Nov., 1910.) The investigation was made with a large vacuum spectrobolometer [see Ibid. p. 768]. Two groups of rays were used, the residual rays from quartz, mean wave-length 8·8 μ; and the CO_2 radiation from a Bunsen flame, wave-length 4·8 μ. The smallest grating constant used was 0·0128 mm., or 7 times the width of grooves on gratings ruled on Rowland's first machine; the largest 0·05 mm. Fresnel's method is adopted of discussing the interference between secondary wavelets originating on the surface of the wave-fronts reflected from the oblique faces of the grooves. This method holds only when the groove-width considerably exceeds the wave-length of light. The smallest groove-width in this case was 1·5 times the wave-length of the longest waves. In the echelette [Abstract No. 58 (1911)] practically the whole surface is operative, and the conditions are quite different from those in the case of a wire grating, or a reflection grating with black lines. A large number of gratings have been examined, and the work is not completed. All the grooves were ruled with a 120° carborundum crystal. Other types of groove will be tried, and it seems probable that a 90° groove will be best. The arrangement of apparatus was as follows: The light from a Nernst filament, rendered parallel by a concave mirror, was reflected from three large polished surfaces of quartz, and focussed upon the slit of the vacuum spectrobolometer by a second concave mirror. The diffraction spectra were caused to pass along the bolometer strip, and the curves representing intensity distribution plotted. A small chart given in the paper summarises briefly the results of the curves, and gives an idea of the positions and magnitudes of the spectra of different orders obtained with each grating. The results for each grating are described in detail verbally. They are complicated by the fact that the energy distribution varies with the angle of incidence, and that the instrument at disposal did not permit of working with fixed incidence. However, the results obtained so far appear to be in excellent agreement with theory, and show that the method gives reliable experimental data regarding distribution of energy as a function of groove-form. They indicate that diffraction of the radiation from the reflecting planes prevents the concentration of all the energy in a single spectrum, but that with a suitably sloped groove 70 per cent. of the energy can be utilised. The paper is only a preliminary one. The precise nature of the ruled surface will be more closely investigated, and the gratings will be studied with a wider range of wave-length. A. E.

233. *Infra-red Investigations with the Echelette Grating: Resolution.* **A. Trowbridge and R. W. Wood.** (Phil. Mag. 20. pp. 898–901, Nov., 1910.)—In the course of the investigation described in the preceding Abstract, it transpired that the echelette gratings give the highest resolving power that has yet been applied to the remote infra-red region of the spectrum; intensity curves, for the Reststrahlen reflected from quartz and the CO_2 radiation from the Bunsen flame, are given in illustration. In the intensity curve of the quartz bands, as obtained by all previous investigators, the longer wave-length maximum is considerably higher than the shorter wave-length one, and the minimum between is very shallow. In the curve obtained with the echelette, the maxima are nearly the same height, and the minimum between them is very much deeper than when observed with a rock-salt prism, its intensity being only ⅓ that of the maxima. The wave-lengths of the maxima found from careful measures are 8·41 μ, 8·90 μ. In the case of the CO_2 radiations, there is distinct resolution of the strong band at 4·8 into a double band. In addition to the strong band, there are weaker maxima to the right and left, at 2·8, 5·4, &c. The values 4·32 and 4·48 μ were found for the two brightest maxima. With another grating, the values 4·2, 4·4, 4·5 μ were found for the three maxima. As regards previous work, Julius found a band at 4·4, which he failed to resolve, and one at 2·8. Rubens and Aschkinass found also a weak band at 14·1. Water-vapour has a band at 5·4. Comparison of the dispersion of the gratings with that of rock salt and fluorite prisms in the interval 4 μ to 5 μ shows that, near the CO_2-band, the echelette dispersion is nearly 17 times that of a 60° rock-salt prism, and 4 times that of a fluorite one. Near the quartz bands, an echelette of grating constant 0·0128 mm. gives 5·4 times the dispersion of a standard 60° salt prism. A. E.

234. *Polarised Phosphorescence.* **J. Becquerel.** (Comptes Rendus, 151. pp. 859–861, Nov. 14, 1910.)—The phosphorescence spectrum of a ruby obtained at low temperatures was polarised so that the ordinary and extraordinary emission spectra were juxtaposed in the spectroscope. The ruby was illuminated by two sources, one at the side, to excite phosphorescence, and the other, of a red colour, placed behind to produce the absorption spectrum. All the phosphorescence colours of ruby (690 to 710 μμ) occur with more or less intensity in the absorption spectrum. When the intensity of the red source was increased a reversal of the rays took place, bright bands becoming absorption bands. When phosphorescence is produced by means of polarised light, if the direction of the exciting light is varied and also the orientation of the vibrations with respect to the crystal, the two spectra of phosphorescence are always obtained together, and reversal of any one ray occurs simultaneously in the ordinary and the extraordinary spectrum.

G. E. A.

235. *Phosphorescence.* **L. Bruninghaus.** (Annal. Chim. Phys. 20. pp. 519–546, Aug., and 21. pp. 210–288, Oct., 1910.)—A phosphorescent substance is shown to consist of an absorbing substance (phosphorogene) dissolved in small quantities in a transparent insulating substance (diluent). The bands of the phosphorescence-spectrum usually fall between the bands of the absorption-spectrum of the phosphorogene or outside, but do not usually coincide with them. For the common elements the phosphorescent colours are the same as those of the salts of the phosphorogene when examined in mass or in solution. The proportions of the phosphorogene vary from 1/100 to 1/1000000, and are often far below those which can be detected by ordinary analytical methods. For each mixture there is a definite concentration of phosphorogene which produces a max. effect, the theoretical significance of which is discussed at length. It is shown that the phosphorogene actually forms a solid solution in the diluent; in some cases the saturation-limit is reached at relatively small concentrations, but these are usually far beyond those required to produce the max. phosphorescence, and in some instances a complete series of solid solutions is formed. T. M. L.

236. *Phosphorescence.* **W. E. Pauli.** (Deutsch. Phys. Gesell., Verh. 12. 20. pp. 809–812, Oct. 30, 1910. Paper read before the 82. Naturforscherversamml. Königsberg, Sept. 22, 1910.)—The author studied the phosphorescence of "phosphores" of the alkaline earth metals, both in the ultra-violet and the infra-red. The phosphorescence bands were recorded by means of photography. In the case of the infra-red bands the plates were sensitised with dicyanine, which sensitises up to 950 μμ. The greatest number of ultraviolet bands is shown by the Ca phosphores, whereas the Ba phosphores show none. These bands do not go further than 300 μμ, unless the preparations are strongly excited with kathode rays, in which case they may go as far as 200 μμ. The extinction of a given band must be measured in connection with the totality of the other bands, as these influence the rate of extinction. Lenard's law, according to which the wave-length of a band is proportional to (dielectric constant)$^{\frac{1}{2}}$ of the medium (sulphide) in which the oscillating atom is immersed, is confirmed. The author gives recipes for two peculiar phosphores: (1) 2 gm. CaS, 0·1 gm. K_2SO_4, 0·0002 gm. Ag, which emits ultra-violet light only; and (2) 3 gm. SrS, 0·07 gm. CaF_2, 0·07 gm. K_2SO_4, 0·00006 gm. Ni, which emits infra-red phosphorescence only. E. E. F.

237. *Studies in Luminescence.* XIV. *Further Experiments on Fluorescence Absorption.* **E. L. Nichols** and **E. Merritt.** (Phys. Rev. 31. pp. 500–512, Nov., 1910.)—[See Abstracts Nos. 555, 914, 1714, 1715 (1910).] The experiments here described have convinced the authors that their own and Miss Wick's previous results are due to some systematic error, and that the supposed increase in absorption, due to fluorescence, either does not exist or is

too small to be detected by their methods. The nature of the error has not been determined. Neglect of slit-width correction is one possible source of error. Some of the results, but not all, may be explained by a peculiar relation between slit-opening and intensity, which is discussed. It is found that, with the Lummer-Brodhun spectrophotometer, the intensity of the transmitted light is proportional to the slit-width for wide slit, but not for narrow slit. For narrow slit the intensity diminishes less rapidly. It seems probable that this effect, due possibly to diffraction or to reflection from the jaws of the slit, is common to all instruments of this type. A. E.

238. *Speed of Röntgen Rays.* **E. Marx.** (Ann. d. Physik, 33. 6. pp. 1305-1391, Dec. 20, 1910. Phys. Zeitschr. 11. pp. 952–956, Nov. 1, 1910.)—Describes a re-determination, by an electric wave interference method, of the speed of propagation of Röntgen rays. The result obtained is within 3 per cent. of the speed of light. Elaborate diagrams and details of the apparatus are given, also large sheets of curves. E. H. B.

239. *Deflection by an Electrostatic Field of RaB on Recoil from RaA.* **S. Russ** and **W. Makower.** (Phil. Mag. 20. pp. 875–882, Nov., 1910.)—A wire was exposed to RaEm for about 10 min. so as to acquire an activity due to RaA. After removal of the adhering emanation, this wire was placed *in vacuo* and a pencil of RaB atoms due to the recoil of the α-particles given off by the disintegrating RaA [see Abstract 382 (1910)] was allowed to travel between two parallel plates connected to a battery and fall on a metal plate placed at right angles to the path. The authors examined the distribution of the activity on this plate with and without the electric field, and found the recoil atoms to be deflected by the field in a direction indicating them to be positively charged. Assuming these recoil RaB atoms to possess the unit charge of electricity and also the momentum of an α-particle of RaA, their atomic weight calculated from the observed electrostatic deflections was found to be of the same order as that to be expected on the disintegration theory of radio-activity (*i.e.*, 214). E. M.

240. *Heterogeneity of β-Rays from a Thick Layer of RaE.* **J. A. Gray** and **W. Wilson.** (Phil. Mag. 20. pp. 870–875, Nov., 1910.)—O. v. Baeyer and O. Hahn [Abstract No. 1710 (1910)] have shown by the photographic method that the β-rays from single radio-active products are initially homogeneous; while J. A. Gray [Abstract No. 1439 (1910)], using the same method, found that the β-rays from a thick layer of RaE were distinctly heterogeneous although they were absorbed according to an exponential law by Al. In the present experiments the β-rays from a thick layer of RaE have been examined by the magnetic deflection method of W. Wilson [Abstract No. 1888 (1909)] and found to be heterogeneous, thus confirming Gray's result. The authors conclude, therefore, that the absorption of β-rays according to an exponential law is no criterion of homogeneity. E. M.

241. *The Period of Ionium.* **F. Soddy.** (Le Radium, 7. pp. 295–300, Oct., 1910.)—The period of ionium still remains a matter of doubt. In this paper a short description is given of experiments having this point in view. These suggest very strongly that the Ra present in Portuguese autunite is often Ra deposited at the beginning with Ur, and not formed from the latter. This would only be the case with specimens of age not greater than some

thousands of years. This is exactly what the He-content indicates. If this idea is correct, then, specimens having a high Ra ratio but containing practically no He should also contain little or no ionium or Ac. According to this new idea, that at the beginning the autunite contains a fraction of Ra n of that of equilibrium, and no ionium, the fraction of Ra ought to decrease with the time to a minimum m which is given by $1-m=[1+n(z-1)]^{1/(1-z)}$ in which $z=\lambda_1/\lambda_2$ is the period of mean life of ionium in function of that of Ra taken as unity. Likewise the relation $1-x=e^{-\lambda_2 T}$ in which x is the proportion of Ra, is exactly true at the minimum and approximately true after that. It is hoped that the period of ionium may be determined in this manner. The results obtained from the examination of this specimen of autunite indicate that the period of ionium is 182,000 years. A. E. G.

242. *Radio-active Equilibrium in Vesuvian Colunnite.* **P. Rossi.** (Accad. Lincei, Atti, 2. pp. 578–583, Dec. 4, 1910.)—From a comparison of the α- and β-radiations from cotunnite, projected from Vesuvius in 1872 and 1907, it is concluded that the latter, when examined in 1907, shortly after its projection, had not nearly reached radio-active equilibrium, but contained RaD, RaE, and a very small quantity of RaF. The contrary conclusion arrived at by Zambonini [Abstract No. 1858 (1907)] is attributed to the fact that he used in his experiments a Curie electroscope, which is sensitive to both the α- and β-rays. The extremely small amount of RaF present explains Piutti's inability to detect any helium in cotunnite. W. H. Si.

REFERENCES.

243. *Portable Interferometer for Liquids and Gases.* **F. Löwe.** (Zeitschr. Instrumentenk. 30. pp. 321–329, Nov., 1910.)—Description of a refractometer on the Rayleigh principle for the use of chemists in gas analysis and in the determination of small differences in the salinity of solutions. With the longer of the two instruments described a difference of 3×10^{-6} in the refractive index can be detected. G. E. A.

244. *Binocular Photometer.* **H. Kruss.** (Zeitschr. Instrumentenk. 30. pp. 329–334, Nov., 1910.)—The measurements of Stigler show that binocular photometry is more accurate than uniocular, and a train of prisms is described which is adapted to the Lummer-Brodhun photometer for use with binocular vision. G. E. A.

245. *Refractive Index of a Gas and its Mean Free Path.* **H. Sirk.** (Akad. Wiss. Wien, Sitz. Ber. 119. 2a. pp. 665–674, May, 1910.)—A theoretical paper in which it is endeavoured to find a relation between the refractive index of a gas, the mean free path of its molecules, and the forces acting between those molecules. [See Abstract No. 1069 (1909).] E. H. B.

246. *Spectrum Displacements due to Pressure.* **A. Stephenson.** (Phil. Mag. 20. pp. 788–790, Oct., 1910.)—Mathematical.

247. *Electrical and Spectroscopic Properties of the Arc between Metal Poles.* **C. Fabry and H. Buisson.** (Journ. de Physique, 9. pp. 929–961, Dec., 1910.)—The full paper corresponding to Abstract No. 1818 (1910).

HEAT.

248. *Specific Heats and Gas Equilibria by Explosion Experiments.* II. **M. Pier.** (Zeitschr. Elektrochem. 16. pp. 897–903, Nov. 1, 1910.)—By means of a manometer previously described the author has determined the molecular heats of oxygen, SO_2 and CO_2 between 0° and 2100° C. at constant volume. For CO_2 and SO_2 the molecular heat is expressed by—

$$C = 6{\cdot}800 + 8{\cdot}8 \times 10^{-3}t - 0{\cdot}95 \times 10^{-6}t^2 + 0{\cdot}1 \times 10^{-9}t^3\,;$$

for oxygen $C - 4{\cdot}900 + 0{\cdot}00045t$. By this method, for an unknown reason, the water-gas equilibrium could not be determined. A. F.

249. *Some Calorimetric Methods.* **W. P. White.** (Phys. Rev. 31. pp. 545–561, Nov., 1910.)—The author discusses different calorimetric methods, and concludes that for the greatest accuracy and usually for convenience, it is well to have (1) a jacket whose temperature is measured directly, completely surrounding the calorimeter; (2) the calorimeter cover in contact with the water so that all bodies at uncertain temperatures are avoided; and (3) evaporation made very small. The method is specially advantageous where bodies are dropped into the calorimeter. In order to apply Newton's law of cooling, the temperature interval must be small; and, in order to avoid this, the author, instead of arranging that the cooling rates shall be proportional to the temperatures, corrects the temperatures so that they shall be proportional to the rates. In this way large temperature intervals can be employed. If, however, a small temperature interval is necessary, the requisite accuracy can usually be obtained by electrical methods. A. F.

250. *Lag Effects and other Errors in Calorimetry.* **W. P. White.** (Phys. Rev. 31. pp. 562–585, Nov., 1910.)—In this communication the author considers the different lag errors in calorimetry, and draws the following conclusions: (1) The error from thermometric lag is rigorously zero for the assumptions usually made as to the lag of the thermometer, so long as one thermometer is used throughout. (2) Other lags, in the water, in the metal parts of the calorimeter, and in the surrounding air, are all proportional to the total temperature-rise, are wholly or largely independent of the rate of heating, and are, moreover, so small as to be usually quite negligible. (3) The real sources of error lie in temperature measurement; in lack of uniformity in temperature, especially of the jacket; in variation in the heat of stirring; and in variation in evaporation. Of these, the first is the most serious. It diminishes proportionally with increase in the temperature interval, and such increase is at present one of the most effective methods available for increasing accuracy. The second source of error can be avoided by having absence of large projecting masses, a calorimeter cover in contact with the water, thorough stirring of the jacket water, and a complete enclosure by the jacket. Appreciable error from the heat produced by the stirring can always be avoided, and evaporation from the calorimeter water can be made regular within a complete enclosure, if this is not too small. With proper precautions the cooling correction is not an appreciable source of error. The author also discusses the advantages of a number of methods and variations in procedure. A. F.

251. *Laws of Radiation.* **E. Baisch.** (Deutsch. Phys. Gesell., Verh. 12. 20. pp. 813–816, Oct. 30, 1910. Paper read before the 82. Naturforscherversamml. Königsberg, Sept. 22, 1910. Phys. Zeitschr. 11. pp. 1056–1057, Nov. 15, 1910.)—Tests the Wien-Planck law of radiation of a black body in the region of the violet and ultra-violet by measuring the intensity of given wave-lengths at different temperatures. The relation deduced from the law in question for small values of λT is $\log_e E_1 - \log_e E_2 = (c_2/\lambda)(1/T_2 - 1/T_1)$. The black body was an Heraeus furnace containing a Pt cylinder closed at one end. The radiation from this was photographically compared with the radiation from two Osram lamps, and the wave-length was selected by means of a quartz spectrograph. The limit of error attained was 6 per cent. The value of c_2 ranged from 1523 at 490 $\mu\mu$ to 1433 at 385 $\mu\mu$. Paschen gives the value 1444. E. E. F.

252. *Mechanical Bases of Thermodynamics.* **P. Hertz.** (Ann. d. Physik, 33. 2. pp. 225–274, Aug. 30, and 33. 3. pp. 537–552, Sept. 22, 1910.)—The kinetic theory of gases is necessarily incomplete so long as its methods are not extended to solids. Its most important theorem, viz., that all gases having an exchange of heat with the atmosphere through the containing walls, have at the same pressure the same number of molecules per unit volume, can only be deduced when the processes within the wall itself are dealt with. The author's work is intended as an introduction to statistical mechanics and to Gibbs's thermodynamics. The temperature and entropy of a real body can be deduced either from a totality of objects in space, with the help of the calculus of probabilities, or from the totality of its possible changes. The former is called a canonic totality, and the latter a microcanonic totality. The importance of the latter was first emphasised by Einstein. In the present work the microcanonic method is fully elaborated and applied to ideal gases, and to adiabatic, reversible, and irreversible processes. E. E. F.

253. *Increase of Entropy.* **H. Happel.** (Ann. d. Physik, 33. 2. pp. 275–290, Aug. 30, 1910.)—Attempts to extend Boltzmann's proof of the theorem of entropy and Maxwell's law of distribution to real gases and to liquids. The conceptions of van der Waals are taken as valid, and the deductions apply to binary mixtures as well as simple substances. It is assumed (with van der Waals) that the molecules are perfectly elastic and spherical. The substances are uniformly distributed in a limited volume, and enclosed in a non-conducting envelope. The author gives a kinetic proof of the law of max. entropy. This applies even to the case when the binding mixture is partly liquid and partly gaseous, so long as the transition between the two states is continuous. E. E. F.

REFERENCE.

254. *Report on Gaseous Combustion.* **W. A. Bone.** (Chem. News, 102. pp. 259–262, Nov. 25; 271–273, Dec. 2; 284–286, Dec. 9; 297–298, Dec. 16; 309–311, Dec. 23; and pp. 323–325, Dec. 30, 1910. Paper read before the British Assoc. at Sheffield, 1910.)—Summarises the results of the principal researches upon the chemical aspects of gaseous combustion during the past thirty years.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

255. *Electricity from Falling Drops of Water.* **A. Schmauss.** (Ann. d. Physik, 32. 4. pp. 871–882, June 21, 1910.)—The author has previously shown that drops of water on falling through ionised air take up a *negative* charge [see Abstract No. 710 (1910)]. Seeliger experimenting with ordinary water in Munich, found that in ordinary air no negative charge was gained, and when ionised by Röntgen rays only a quite feeble negative charge was assumed. To explain this, Seeliger supposes a charge-effect due to Volta p.d. The author in the present paper seeks to show that Seeliger's explanation is not tenable, and, further, goes on to explain the cause of the want of agreement between his own results and those of Seeliger. It appears that the taking-up of an ionic charge from the air depends on the kind of water used, and while Schmauss' result is obtained with distilled water, Munich tap-water behaves in the way described by Seeliger. Experiments with NaCl solution show that this assumes a positive charge when it falls in drops through ionised air, and, in general, Seeliger's results may be explained by the following experimental facts: (1) Distilled water which exhibits a positive charge as Lenard-effect, takes up a negative charge in the drop experiments; (2) NaCl solutions (and perhaps also Munich tap-water) which shows a negative charge as Lenard-effect, takes a positive charge. The opposite behaviour of distilled water and NaCl solution shows that a charge action caused through Volta p.d. of the metallic parts of the apparatus is not the explanation of the effects, but that there must rather be assumed specific forces acting between the liquid drops and the surrounding positive and negative ions. The drops may draw to themselves those ions whose charge is opposite to their own on account of the charge arising from the Lenard double-layer. J. J. S.

DISCHARGE AND OSCILLATIONS.

256. *Electrical Conductivity of Salt Vapours.* **G. C. Schmidt.** (Deutsch. Phys. Gesell., Verh. 12. 20. pp. 764–775, Oct. 30, 1910. Paper read before the 82. Naturforscherversamml. Königsberg, Sept. 20, 1910. Phys. Zeitschr. 11. pp. 967–972, Nov. 1, 1910.)—The salt under investigation was placed in a quartz tube, and just above it was arranged a central Pt electrode and a concentric cylindrical electrode. The salt was then heated to a given temperature, generally below the melting-point, and observations were made of the current between the electrodes. With CdI_2 the current diminished rapidly with time, while with ZnI_2 there was first an increase to a maximum, and then a decrease. The author has investigated the reason of this behaviour, and finds it to be due to (1) decrease of mobility of the ions with time owing to their being in the form of larger aggregates; (2) a decrease in the number of ions; and (3) dissociation of the salt; in the case of CdI_2 into Cd and iodine. Thus the conditions of equilibrium of such a vapour are very complicated, and in order to get consistent results on the ionic constants of these salts it is necessary to wait about 3 hours till chemical equilibrium is reached. Under these conditions the author has determined the influence of temperature on the conductivity, and with increasing temperature finds it to increase slowly

at first and then more quickly, the curve having the same shape as that showing the influence of temperature on the conductivity of solid salts. From these experiments and the Nernst law of distribution of ions at a given temperature the author concludes that in the liquid condition uncharged molecules must attach themselves to the ions. E. M.

257. *Diffusion of Gaseous Ions.* **E. Salles.** (Comptes Rendus, 151. pp. 712–714, Oct. 24, 1910.)—The paper deals with experiments in continuation of those previously described [Abstract No. 2002 (1908)], and the author gives values of the diffusion coefficients for the ions of various gases. The values are :—

Gas.	D for + Ions.	D for − Ions.	Mean.	Ratio.
Air	0·032	0·042	0·037	1·31
Carbon dioxide ...	0·025	0·026	0·025	1·04
Nitrogen	0·029	0·0414	0·035	1·41
Oxygen	0·030	0·041	0·035	1·36

These results differ slightly from those of Townsend, the author urging that Townsend's air was not sufficiently dried, and his oxygen not sufficiently pure. The author has also made experiments on the diffusion coefficients of air and nitrogen at pressures greater than 1 atmo., and gives results which show that the product of the pressure and diffusion coefficient does not alter very much with pressure up to 1800 cm. Hg. E. M.

258. *Positive Thermions from Alkali Salts.* **O. W. Richardson.** (Phil. Mag. 20. pp. 981–999, Dec., 1910.)—Previously described experiments by the author and Hulbirt [see Abstracts Nos. 117 (1909); 118 (1911)] led them to the conclusion that the constancy of the value e/m and its approximation to the known value for sodium in the thermion emitted by various metals, showed that the bulk of the thermions were due to sodium present as an impurity. Similar experiments on the sulphates of Li, Na, K, Rb, and Cs, confirmed these conclusions by showing that the positive ions were atoms of the constituent metal. They also showed that each atom carried the same charge as the hydrogen atom in electrolysis, the final conclusion being that each thermion consists of an atom of the basic metal which has lost a negative electron. No negative thermions other than negative electrons were detected. (Ibid. pp. 999–1000, Dec., 1910.)—These conclusions were further confirmed by similar results being obtained with fluoride and iodide of sodium.

G. W. de T.

259. *Initial Velocity of Photo-electrically Liberated Electrons.* **O. v. Baeyer** and **A. Gehrts.** (Deutsch. Phys. Gesell., Verh. 12. 21. pp. 870–879, Nov. 15, 1910.)—A surface covered with soot, similar to that used by Ladenburg and Markau (Abstract No. 1827 (1908)], is first employed. It is concluded that the true initial velocity of the electrons depends to an important degree upon the nature of the surface from which they are emitted. This velocity can only be observed if the secondary appearances due to the electrons striking metal particles (reflection of electron radiation) are avoided. The influence of this source of error is of a fairly complicated nature, since the strength of this reflection depends on the velocity of the photo-electrically emitted elec-

trons. The values of the initial velocity with Au, Cu, and Al, the surfaces being as clean as possible, are practically equal. The greatest value, 6·8 volts, corresponds with the shortest efficient wave-length of about 200 $\mu\mu$.
A. E. G.

260. *Photoelectric Effect of Incident and Emergent Light.* **O. Stuhlmann, Jr.** (Phil. Mag. 20. pp. 331–339, Aug., 1910.)—Cases in which the transmitted radiation is greater than the incident radiation have been found in γ-rays [Abstract No. 412 (1908)], β-rays [Abstract No. 469 (1909)], and secondary Röntgen rays [Abstract No. 1226 (1909)]. The present work describes a similar behaviour of ultra-violet light so far as its photoelectric efficiency is concerned. Thin films of Pt were prepared by kathode disintegration on a basis of quartz. Two such quartz plates were mounted in brass cylinders placed end to end, and a beam of ultra-violet light from an iron arc was passed through them. The saturation current from the illuminated plates to the cylinders was measured in two positions. In the first position the films were both turned towards the source; in the second, the film first encountered by the light was turned away from the source. If there were no difference in the photoelectric effect of an incident and an emergent beam, the second position should show a smaller effect, owing to the absorption of the quartz. But with thin films the reverse is always the case; hence the emergent beam has a greater photoelectric effect than the incident beam.
E. E. F.

261. *Formation of Kathode Rays.* **L. Dunoyer.** (Le Radium, 7. pp. 300–309, Oct., 1910.)—The first part of this paper contains a further account of experiments previously described [see Abstract No. 962 (1910)]. In addition it is now found that the curious phenomena observed by distilling sodium in a vacuum tube through which a discharge is subsequently passed can also be obtained when potassium, rubidium, or caesium is substituted for sodium. Zinc also has been used for the same purpose with success, but a higher voltage is required in this case. In certain tubes it is found that after the p.d. is removed from the electrodes, if these latter are connected, the small spots remain bright for 1 or 2 min., their brightness gradually diminishing until they are no longer visible to the eye. A tube of H-form is very useful when making these observations. A further explanation is now offered based upon the assumption that the kathodic afflux strikes the small metallic drops, thus heating them and causing them to emit electrons. The general conclusion is drawn that there are two distinct ways in which kathode rays are formed: one in which they are produced in the gas by the acceleration of corpuscles detached from the molecules of the gas; the other in which they are produced at the surface of the kathode on account of the local heating which momentarily take place in the regions of impact of the kathodic afflux. The first method should preponderate at relatively high pressures, and the second without doubt is almost exclusively responsible for the formation of the kathode bundle proper at very low pressures.
A. E. G.

262. *Photoelectric Fatigue of Metals.* **H. S. Allen.** (Phil. Mag. 20. pp. 564–578, Oct., 1910.)—The fatigue was investigated by means of a photoelectric current from a zinc plate (polished with fine emery paper) to a positively charged wire gauze. The fatigue proceeds in darkness almost at the same rate as when the metal is continuously exposed to light, although light probably exerts a small secondary action. The rate of fatigue does not depend

upon the strength of the electric field, but the reading taken immediately after reversal is greater than the normal, as in the case of leak from hot bodies. The activity for some hours after polishing can be represented as the sum of two exponential terms, with the addition of a small constant term, which gives the residual activity perceptible after as long as 26 days. In hydrogen the fatigue of Zn is about the same as in air. Pure Ag exposed to air or hydrogen in a small space shows no fatigue. In the open air it does. Aluminium and Cu behave nearly like Zn. In the case of Cu the activity falls to half in about 8 hours. The cause of fatigue must be sought in the condition of the surface film of gas or the gas occluded in the metal. E. E. F.

263. *The Glow Discharge in Rubidium and Caesium Vapours.* **G. Gehlhoff.** (Deutsch. Phys. Gesell., Verh. 12. 22. pp. 968–969, Nov. 30, 1910.)—In the experiments with potassium and sodium vapours [see Abstract No. 1815 (1910)] it was not found practicable to measure the kathode-fall on account of the breakdown of insulation of the glass at the high temperatures required. For this reason Rb and Cs which vaporise at much lower temperatures are now used. The progressive heating of the discharge tube produced similar phenomena to those observed with sodium and potassium. It is found very difficult to obtain a measurement of the normal kathode-fall in Rb vapour, but it is quite easily accomplished in Cs vapour. With temperature between 170 and 210° C., and currents between 0·4 and 0·7 × 10^{-8} amp. the mean value obtained is 840 volts. An account is also given of the spectroscopic analyses of the light in the tubes containing these vapours when a discharge passes. A. E. G.

264. *Nature of Coloured Layers formed by Electric Discharges on Alkali Metals.* **J. Elster** and **H. Geitel.** (Phys. Zeitschr. 11. pp. 1082–1088, Nov. 15, 1910.)—The substances obtained by Fischer and Schröter by passing an arc between alkali metal electrodes under liquid argon [Abstract No. 1858 (1910)] are probably identical with those obtained by the authors [see Abstract No. 958 (1910)]. This follows from the coincidence in colour and the instability of both series of substances. These substances are modifications of the alkali metals themselves, and the presence of hydrogen in the authors' method of procedure is only of importance as rendering easier the production of these allotropic forms. G. E. A.

265. *Discharge Potential in the Magnetic Field.* **Gouy.** (Comptes Rendus, 151. pp. 1020–1023, Dec. 5, 1910.)—The effect here studied is the action of the magnetic field upon the passage of a continuous current in high vacua, when interkathodic action which produces so great a lowering of potential is entirely excluded [see Abstract No. 1125 (1910)]. To avoid secondary kathodes the anode is in the form of a cylindrical sheet of metal so arranged that the open ends are at those places far from points which are struck by the magneto-kathodic bundles. Experiments performed with the kathode in the axis of the cylinder show that if very weak fields are excluded, the magnetic field multiplies the potential by a factor N, which becomes so much the greater the shorter the magneto-kathodic bundle; the value of N also depends to some extent upon the current and the vacuum. If the kathode is placed near the side so that the magneto-kathodic bundle has a length of 6·5 cm., N is less than unity. It appears from other experiments that the bundle is rich in positive ions, and that it is the chief source of these ions in the bulb. If this is so, the afflux of positive ions to the kathode requires a fall of potential so much the less as the magneto-kathodic bundles are more developed. A. E. G.

266. *Ionisation and Luminescence in the "Aureole" from a Mercury Lamp.* **W. Matthies.** (Deutsch. Phys. Gesell., Verh. 12. 20. pp. 754–764, Oct. 30, 1910. Paper read before the 82. Naturforscherversamml., Königsberg, Sept. 20, 1910.)—The mercury lamp used was of the Arons type with a side tube inserted in the middle of the arc. This side tube contained two electrodes of wire gauze and was continuously connected to a Gaede pump. A stream of luminescent vapour [" Aureole," see also Abstract No. 186 (1910)] which contained charged particles was thus produced in the side tube. The author finds that under similar conditions the ionisation between the two wire-gauze electrodes is practically independent of the length of the arc, while it is approximately a linear function of the energy spent in unit volume of the arc. With diminished pressure the ionisation increases to a maximum and then decreases, the author concluding that the " carriers " are, in general, positive and negative ions of small mobility, together with negative electrons. The current between the electrodes was found to decrease the luminescence by taking away the ions, thus verifying Stark's hypothesis. E. M.

267. *Alternate-current Arc Experiments.* **G. Jäger.** (Akad. Wiss. Wien, Sitz. Ber. 119. 2a. pp. 685–695, May, 1910.)—If two rods of different metals are connected to each other through a direct-current galvanometer and their ends be placed near each other, as symmetrically as possible, in an alternate-current arc, a considerable current is registered on the galvanometer. The p.d. between the metals may be several volts. It arises not only from the difference of the metals, but also from temperature differences, as is shown by the fact that two rods of the same metal with their ends at places of different temperature in the arc give rise to a p.d. of more than 1 volt, the colder electrode being at the higher potential. The resistance between an electrode and the arc is very great, if the electrode is cold, but falls off rapidly as the electrode rises in temperature. No polarisation of the electrodes is observable. T. P. B.

268. *The Action of a Condenser in an Induction Coil.* **J. W. Waghorn.** (Electrician, 66. pp. 172–175, Nov. 11, 1910.)—Experiments are described which were made for the purpose of determining the oscillations set up in a condenser bridging a spark-gap on a circuit arranged like the primary of an induction coil. The case when the circuit is made and broken by a motor mercury interrupter is specially considered. It is shown that two sets of oscillations can occur simultaneously in the condenser circuit. The sparking distance is affected very largely owing to the oscillatory nature of the discharge. The largest quantity of electricity set in motion in this circuit, and the max. spark length correspond to comparatively small condenser capacities and to relatively large values of the primary circuit inductance. When there is no liquid dielectric there are practically no oscillations. A. R.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

269. *Electrical Properties of Selenium.* III. **L. S. McDowell.** (Phys. Rev. 31. pp. 524–535, Nov., 1910.)—The present paper, following previous work, describes further experiments to show the change in the resistance of

a selenium cell and the form of the resulting recovery curve produced by (i) a sudden increase in temperature, (ii) exposure to light at low temperatures. The chief results may be summarised as follows: (1) The action of light and heat in producing change in the conductivity of selenium is apparently identical. (2) The increase in resistance with decrease in temperature continues down to the temperature of liquid air where the cell becomes almost entirely non-conducting. (3) Change in conductivity due to excitation by light of the same intensity takes place more slowly at low temperatures than at ordinary temperatures, but the final change produced by saturation is enormously greater. (4) Recovery at low temperatures is markedly slower than at ordinary temperatures. [See Abstract No. 977 (1910).] E. H. B.

270. *Metallic Conduction of Electricity.* **Bædeker.** (Le Radium, 7. p. 238, Aug., 1910. Paper read before the Congrès Internat. de Radiologie, Brussels, Sept., 1910.)—When CuI is introduced into the vapour of iodine or a solution of iodine the compound can combine in a reversible fashion with a measurable quantity of iodine and then becomes a conductor of electricity. Thin transparent layers of copper obtained by kathodic pulverisation of Cu and afterwards exposed to iodine are suitable for experiment, and their conductivity is found to be of a metallic character chiefly. Thus there is obtained a conductor with variable concentration of electrons and its conductivity may be considered as proportional to such concentration. From theory the Hall-effect is proportional to the velocity of the electrons, and hence the Hall-coefficient should be inversely as the concentration, *i.e.*, inversely as the conductivity. This was experimentally verified. Preliminary experiments also indicated that the thermo-e.m.f. (proportional according to the electron theory to the logarithm of the concentration) was proportional to the conductivity. J. J. S.

271. *The Thomson-effect in Iron.* **A. Aalderink.** (Archives Néerlandaises, 15. 3. and 4. pp. 321–352, 1910.)—Details are given of an elaborate series of researches on the value of the Thomson-effect in iron; these form part of a set of observations undertaken with a view to finding various thermal and electric data necessary for the theory of a thermoelectric chain—that of iron-mercury. The research was commenced by Haga, and the earliest part was published in 1885. Between the temperatures 60° and 120° the values found for the Thomson-effect in the specimen of iron used (which was found when analysed to be almost absolutely pure) were satisfactory and concordant. Between these limits the value of the constant, σ, is represented by the equation, $\sigma = (95 - t)\,4{\cdot}9 \times 10^{-6}$. The zero of the Thomson constant thus corresponds to 95°. The change of sign with rise of temperature constitutes an important element in the theory of the phenomenon. J. J. S.

272. *Demonstration of the Thomson-effect.* **W. König.** (Phys. Zeitschr. 11. pp. 913–915, Oct. 15, 1910. Paper read before the Schweiz. Naturforscher. Gesell., Basel, Sept., 1910.)—A simple method of showing the Thomson-effect is described. A Pt-wire bent into a U-shape is arranged so that an electric current is sent through it, the lower ends of the loop being in water. As the resistance of the wire is lessened by cooling, the position of the commencement of the glow due to the passage of the current varies in the two branches of the wire at a distance from the water-cooled surface. That this is caused by the Thomson-effect is shown by the fact that the variation is inverted

when the direction of the current is changed. The wires can be made to glow strongly enough to throw their projection on to a screen. A more accurate means of comparison and observation is also described, enabling quantitative measurements to be obtained. The author's results are preliminary to more extended observations to be taken later. So far his measurements agree with the results obtained by Lecher. J. J. S.

273. *Electromotive Force of Weston Normal Cell.* **H. Haga** and **J. Boerema.** (Konink. Akad. Wetensch. Amsterdam, Proc. 13. pp. 587–595, Dec. 22, 1910.)—The method adopted for the measurement was that of a very carefully constructed tangent galvanometer, the apparatus employed being the same as that used by van Dijk and Kunst in their determination of the electrochemical equivalent of silver. The Weston normal cells used were constructed according to the procedure at the National Physical Laboratory; measurements on thirty-one of these show variations from the mean always less than 1 part in 100,000. The result of the investigation is that the e.m.f. of the cell at 17° C. is $1{\cdot}0188_5$ volts (int. ohm; c.g.s. ampere), a value considered accurate to the fourth decimal. This value is in close agreement with that found (1·01830) by Ayrton, Mather, and Smith at the National Physical Laboratory. [See Abstract No. 469 (1908).] F. E. S.

274. *Mutual Inductance of Two Parallel Coaxial Circles in Terms of Hypergeometrical Series.* **F. W. Grover.** (Bureau of Standards, Bull. 6. pp. 489–502, Nov., 1910.)—Mathy, by introducing the Weierstrassian notation, obtains the mutual inductance of two parallel, coaxial circles in terms of hypergeometrical series instead of the usual elliptic functions [see Abstract No. 655 (1901)]. The author examines the formula obtained, and finds that it is subject to serious limitations. In many cases its error may be as great as 10 per cent. Before using it a preliminary examination is necessary to see whether the series is uniformly converging or not. A special formula is given when the greatest distance, r_1, between points on the two circles is $\sqrt{2}$ times the shortest distance, r_2, between them. [This special formula and many similar ones follow at once from the second form in which Maxwell gives the formula, namely, $M = 8\pi\sqrt{ab}(F - E)/\sqrt{k}$, where k, the modulus of the complete elliptic integrals F and E, equals $(r_1 - r_2)/(r_1 + r_2)$ and a and b are the radii of the circles.] A. R.

275. *Absolute Measurement of Currents of Great Intensity.* **M. Chopin.** (Comptes Rendus, 151. pp. 1037–1040, Dec. 5, 1910.)—With the single-spiral tangent galvanometer it is difficult to accurately measure currents of greater value than 50 amps. This is largely owing to the comparatively small value of H, the horizontal component of the earth's magnetic field. To overcome this difficulty the author adds an artificial field, of known value, to H, and is thereby enabled to measure currents of the order of 1000 amps. with deflections in the neighbourhood of 45°. F. E. S.

ALTERNATING CURRENTS AND MAGNETISM.

276. *Villari-effect in a Periodically Varying Magnetic Field.* **G. Ercolini.** (N. Cimento, 20. pp. 137–148, Aug., 1910.)—This paper is concerned with the effect of traction on the magnetic properties of iron in a field formed by the superposition on a steady field of a coaxial alternating one. The iron, in the form of a wire 0·05 cm. in diam. and 50 cm. long, is placed in a glass tube which is wound with wire. Outside is another glass tube, also wound with wire, and between the two flows a stream of cold water. A steady field H_1 is maintained by direct current through the outer winding and an alternating field H_2 by alternating current (41·2 ∿) through the inner winding. Magnetic moments are measured by means of an astatic reflecting magnetometer. For each value of H_1 from 2·2 to 62·8 four values of H_2 from 0·9 to 84·5 are used, and the tractive force is varied from 1 to 10 kg. The observations of Villari are confirmed—that for steady, weak fields the effect of traction is to increase the magnetisation; for more intense fields the effect reaches a maximum and then decreases; for still more intense fields traction always produces a diminution in magnetisation. The results of the measurements are exhibited in tables. It is shown that, in general, traction produces a smaller increase in magnetisation, or a greater decrease, when the iron is taken along the hysteresis curve than when it is on the curve of first magnetisation. The influence of the alternating field H_2 depends on its value relative to the steady field H_1 on which it is superposed. If H_2 be sufficiently great it is found that traction always produces a diminution in the mean magnetisation, increasing in amount with H_1. Further experiments with still smaller values of H_1 reveal the fact that instead of the great increase in magnetisation which traction causes for small values of H_1 alone, the change produced is only a very slight one if H_2 be great enough. The results may be summarised in the statement that in an alternating field symmetrical with regard to a value greater than 2 c.g.s. units, and of sufficient amplitude, the effect of traction is always to diminish the magnetisation of the iron; if the mean value be less than 2 the variations produced by traction are very small, but always point towards a diminution in magnetisation. H. W. M.

277. *Magnetic Shielding and Electromagnetic Induction in Iron Amalgam.* **L. Stjepanek.** (Phys. Zeitschr. 11. pp. 1088–1090, Nov. 15, 1910.)—An account of an attempt to solve experimentally the following problem. A plane rectangular circuit ABCD, which can rotate about AD, is placed in a uniform field, the lines of force of which are parallel to AD and BC. A current flows round the circuit, causing equal and opposite forces to act on AB and DC. If the side DC is surrounded by an iron tube the forces on AB and DC are no longer equal, and the rectangle will have a tendency to rotate about AD. No such tendency was observed in the arrangement adopted, in which liquid iron amalgam was employed as a magnetic shield. An estimation of the magnitude of effect expected is made, and also an explanation of the non-appearance of the effect. G. E. A.

278. *Magnetic Hysteresis at Liquid-air Temperature.* **R. Beattie** and **H. Gerrard.** (Electrician, 66. pp. 411–415, Dec. 23, 1910.)—Experiments are described showing the effect of low temperature on the hysteresis of iron, carbon steel, nickel, and cobalt in rotating and alternating fields. In the rotating-field tests the torque method was employed, and in the alternating-field tests the loops were determined ballistically. In the case of rotational hysteresis a marked increase in the loss was produced by cooling the materials from 15° C. to —190° C. An increase, though somewhat smaller in amount, was also found in the hysteresis of the metals when subjected to an alternating field, whereas Fleming and Dewar's experiments (1896) showed either no alteration or indefinite results. The increase found by the authors was chiefly due to an enhancement of the coercive force at low temperatures. A. D. R.

279. *Mechanical Stress and Magnetisation of Nickel.* **W. Brown.** (Roy. Dublin Soc., Proc. 12. 37. pp. 500–518, Dec., 1910.)—This paper gives the results of experiments on the magnetisation and torsion of nickel wire, the apparatus and arrangements being the same as were employed by the author in similar experiments on iron [see Abstract No. 145 (1911)]. As in the case of iron, five different degrees of hardness were adopted. The following is a summary of the results of the observations: (1) Soft nickel wire heated to a bright cherry-red heat when loaded at the rate of 10^5 gm./cm.^{2} has its rigidity *increased* about 6 per cent. and its electrical conductivity *decreased* 8·8 per cent. (2) Beyond a certain value of longitudinal magnetic field the twist increases with the load on the wire. (3) The longitudinal magnetic field in which the max. twist occurs is independent of the hardness of the wire, but is different for different loads. (4) The curves obtained with differently loaded wires cross one another in definite longitudinal magnetic fields, whatever the hardness or length of the wire. (5) The longitudinal magnetic field in which the max. twist occurs is independent of the length of the wire, the load being constant. (6) The twist is directly proportional to the length of the wire. (7) The longitudinal magnetic field in which the max. twist occurs is independent of the current density in the wire. (8) The twist is directly proportional to the current density in the wire, whether with different currents through the same wire or the same current through wires of different diams. (9) With nickel wires of different cross-sectional areas the max. twist occurs in the same longitudinal magnetic field. (10) When the cross-sectional area of the wire is increased 4·8 times the increase in the twist is larger the greater the longitudinal magnetic field: thus, in a field of 13 c.g.s. units, the twist is increased 12·6 per cent.; in a field of 30 units, 16·7 per cent.; and in a field of 50 units, 19·8 per cent. (11) When the soft wires of nickel and iron (of the same length, diam., and under the same longitudinal load) are tested under the same conditions the max. twist for nickel (95 mm.) occurs in a longitudinal magnetic field of 13 units, and the max. twist for iron (40·5 mm.) takes place in a field of 2·5 c.g.s. units. J. J. S.

280. *Inductance for Alternating Current of a Circuit enclosing Iron.* **O. Bonazzi.** (Accad. Lincei, Atti, 19. pp. 633–637, Dec. 18, 1910.)—The three methods of defining inductance, and their relations when the permeability is variable are discussed, as are the difficulties of defining the average permeability for a cycle of magnetisation. The author then recommends the following definition for the mean permeability for a cycle—

$$\mu = \int_0^{T/2} B\,dt \Big/ \int_0^{T/2} H\,dt,$$

where the integration extends over half a cycle. The magnetic flux ϕ being proportional to B, and H being proportional to i, we then have for the inductance—

$$L = \int_0^{T/2} \phi\,dt \Big/ \int_0^{T/2} i\,dt,$$

and the relation between L and μ is $L = 4\pi s\mu$, where s is the cross-section of the iron. S. G. S.

281. *Magnetic Hysteresis.* **J. A. Ewing.** (Phil. Mag. 20. p. 1005, Dec., 1910.)—The author criticises the statement of S. P. Thompson [see Abstract No. 1761 (1910)] that in view of the latter's analysis of the hysteresis loop it is necessary to revise the common opinion that magnetic hysteresis is an irreversible process and as such involves a degradation of energy into heat. He points out that hysteresis in the magnetisation of iron means a lagging of the magnetisation behind the magnetising force when this force is changed. The area enclosed by the curve of magnetism and magnetising force measures the energy dissipated in a cyclic process, and this energy is transformed into heat. A. D. R.

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282. *Measurement of Electricity.* **F. Ehrenhaft.** (Akad. Wiss. Wien, Sitz. Ber. 119. 2a. pp. 815–867, May, 1910. Phys. Zeitschr. 11. pp. 940–949; Discussion, pp. 949–952, Nov. 1, 1910. Paper read before the 82. Naturforscherversamml. Königsberg, Sept., 1910.)—Reviews the various determinations of the electrolytic and electronic charge and advocates its adoption as the unit quantity of electricity. E. H. B.

283. *Electric Discharge.* **F. E. Nipher.** (Science, 32. p. 608, Oct. 28, 1910.)—The author has now taken photographs confirming his previous views as to the nature of the electric discharge [see Abstracts Nos. 271, 688, 689 (1909)]. These photographs were shown at the Academy of Science, St. Louis, but are not reproduced. E. H. B.

284. *Use of Thermo-junctions for High-frequency Current Measurements.* **C. M. Dowse.** (Electrician, 65. pp. 765–769, Aug. 19, 1910.)—The author describes a form of thermo-junction suitable for radio-telegraphic measurements in technical colleges. "Eureka" copper junctions have been found satisfactory. The construction adopted is described and tests are given showing that such junctions are reproducible. L. H. W.

285. *Electric Heating and Pyrometry.* **J. A. Fleming.** (Engineering, 89. pp. 751–753, June 10, and pp. 784–786, June 17, 1910. Abstract of Tyndall Lecture delivered at the Royal Institution, 1910.)

286. *Large Induction Coil giving a 51-inch Spark.* (Elect. Rev. 66. pp. 6–7, Jan. 7, 1910.)—Winding and other details relating to a 51-in. and a 30-in. spark coil constructed by C. W. Cox, of Liverpool. L. H. W.

287. *Mathematical Problems in Connection with Radiotelegraphy.* **H. Poincaré.** (Lumière Électr. 13. pp. 7–12, Jan. 7; 35–40, Jan. 14; 67–72, Jan. 21, and pp. 99–104, Jan. 28, 1911.)—An advanced mathematical paper in which the author discusses the determination, from first principles, of the length and damping factor of a wave due to an exciter of given form. A. R.

288. *The Stretching of a Conductor by its Current.* **C. Hering.** (Frank Inst., Journ. 171. pp. 73–85, Jan., 1911. Elect. Engin. 47. pp. 58–61, Jan. 20, 1911. Abstract.)—The author discusses the longitudinal force which acts on a conductor carrying a current and tends to stretch it. A. R.

289. *Measurement of Magnetic Fields.* **H. Zahn.** (Elektrotechn. Zeitschr. 31. pp. 1319–1320, Dec. 29, 1910.)—The author points out two sources from which error is likely to arise in the employment of the Hall-effect in the measurement of the intensity of a magnetic field [see Abstract No. 1838 (1910)] and discusses the precautions which should be taken. A. D. R.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

290. *Electrochemical Behaviour of Cobalt.* **R. Schildbach.** (Zeitschr. Elektrochem. 16. pp. 967–979, Nov. 15, 1910.)—The cobalt salts used, $CoCl_2$ and $CoSO_4$, were especially prepared. The deposition potentials had to be determined under exclusion of air, in atmospheres of hydrogen or nitrogen; in CO_2 more negative potentials were observed. Cobalt can be deposited as pure metal from neutral solutions. In weakly acid solutions (addition of hydrochloric, sulphuric, boric acid) the potentials are more strongly negative than in neutral solutions; this difference vanishes when the solutions are heated; a gas film of hydrogen seems to form on Co. The equilibrium potentials were determined in nitrogen or in a vacuum with powdered Co contained in perforated Pt pockets. As in the case of Ni (A. Schweitzer) the potential becomes more negative, when the solution is diluted and when the temperature is raised. The iron metals pass gradually, especially at higher temperatures, into the active state, Fe most rapidly, Co less rapidly, Ni slowly. In primary cells Co may, like Fe, serve as soluble electrode, Ni not. The potential of Co becomes more negative when it is charged with hydrogen. Reference is made also to Mustad, Schoch, and Richards and Behr.

H. B.

291. *Electrolytic Determination of Chlorine in Hydrochloric Acid with the Use of a Silver Anode and a Mercury Kathode.* **J. S. Goldbaum** and **E. F. Smith.** (Amer. Chem. Soc., Journ. 32. pp. 1468–1471, Nov., 1910.)—The errors which Gooch and Read [Abstract No. 480 (1910)] have found to occur in the method for estimating chlorine by means of a silver anode [see Abstract No. 351 (1909)] are due to the unsuitable nature of the silver surface used. Good results are obtained with 2·5–5 volts, the current strength falling from 0·85 amp. at the commencement of the electrolysis to 0·005 amp. at the end, using a Pt-gauze anode which has been silvered in a cyanide electrolyte, dipped into dilute hydrochloric acid to remove soluble cyanide, washed thoroughly with distilled water, and then heated to incipient redness. The silver should not be heated to such a temperature that it melts, otherwise the porosity of the surface is destroyed and the electrode spoilt. Any silver oxide which may be formed during the electrolysis is destroyed by heating the electrode for 15 min. at 300° in an electric oven. Tables are given showing the accuracy of the method in the analysis of chlorides and bromides.

T. S. P.

REFERENCE.

292. *Conductivity, Dissociation, and Temperature-coefficients of Conductivity at 35°, 50°, and 65° of Aqueous Solutions of a Number of Salts.* **A. P. West** and **H. C. Jones.** (Amer. Chem. Journ. 44. pp. 508–544, Dec., 1910.)—A further instalment of a bulky investigation of which several portions have already been published. As thirteen papers bearing on the subject have already appeared and five investigators are still at work on it, the discussion of the results may be postponed until the authors are able to summarise the results accruing from the completed research. T. M. L.

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